



US 20110045426A1

(19) **United States**

(12) **Patent Application Publication**  
**Kim et al.**

(10) **Pub. No.: US 2011/0045426 A1**  
(43) **Pub. Date: Feb. 24, 2011**

(54) **METHOD AND APPARATUS FOR ENHANCED FLAMEHOLDING IN AUGMENTORS**

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(21) Appl. No.: **12/806,958**

(22) Filed: **Aug. 24, 2010**

**Related U.S. Application Data**

(60) Provisional application No. 61/236,456, filed on Aug. 24, 2009.

**Publication Classification**

(51) **Int. Cl.**  
**F23D 14/46** (2006.01)

(52) **U.S. Cl.** ..... **431/350**

(57) **ABSTRACT**

Techniques for the enhancement of the stability of an after-burning flame in the vicinity of a low pressure loss augmentor are provided by various geometrical modifications of the base region of the augmentor.

## METHOD AND APPARATUS FOR ENHANCED FLAMEHOLDING IN AUGMENTORS

### CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Patent Application 61/236,456 filed Aug. 24, 2009, which is incorporated herein by reference.

### STATEMENT OF GOVERNMENT SPONSORED SUPPORT

[0002] This invention was made with Government support under contract FA9550-08-C-0039 awarded by U.S. Air Force. The Government has certain rights in this invention.

### FIELD OF THE INVENTION

[0003] The invention relates to thrust augmentors used in jet engines. In particular, the invention relates to techniques to enhance flameholding in augmentors.

### BACKGROUND OF THE INVENTION

[0004] Thrust augmentors are used in jet engines as a means to provide additional thrust capability with little mechanical complexity. While the V-gutter has been used in the past, an alternate generic design for the flameholder uses a more streamlined shaped body for reducing the stagnation pressure loss and it includes a bluffbody with a rounded (or elliptic) nose, some streamwise length and a rectangular trailing edge. Fuel is injected through a set of ports upstream of the trailing edge, mixes with the hot gases and eventually forms a flame which is anchored by the recirculation downstream of the trailing edge. The present invention advances the art by disclosing new designs and methods for flameholding in augmentors.

### SUMMARY OF THE INVENTION

[0005] In one aspect, the enhancement of afterburning flame stability and the change of the flow field in the wake region of new, low pressure loss flame augmentors, of variously modified base geometries, are disclosed in a high temperature (~ 1300 K) vitiated flow. Flame liftoff height measurements are characterized by CH chemiluminescence, while the three-dimensional flow field is determined using

stereo particle image velocimetry (PIV). The basic geometry of the augmentor is a rectangular body with a rounded nose. In one aspect, we find that a combination of both 2-D and 3-D geometric changes provides the best flameholding, i.e. the highest flame stability (lowest liftoff height), and furthermore, when local cavities are in phase with the fuel jets, the performance is optimal. Furthermore, it is conjectured from the PIV experiments that the observed stability enhancement is attributed to multi-dimensional vortices induced by both the presence of the local cavity as well as the two-dimensional geometric change.

### DETAILED DESCRIPTION

[0006] Descriptions and figures of various embodiments of the present invention are disclosed in the following appendices:

[0007] Appendix A: A paper (10 pages) entitled "A Method and Apparatus for Improved Flameholding in Augmentors" by Kim et al.

[0008] Appendix B: A paper (4 pages) entitled "Stereo PIV Measurements of a Geometrically Modified Flame Augmentor Base" by Kim et al.

[0009] Appendix C: A paper (33 pages) entitled "Flame Liftoff Height Dependence on a Geometrically Modified Bluff Bodies in a Vitated Flow" by Kim et al.

[0010] Appendix D: A paper (27 pages) entitled "The improvement of blowout limit in partially/fully premixed flames with geometrically modified bluffbody bases" by Kim et al.

[0011] As one of ordinary skill in the art will appreciate, various changes, substitutions, and alterations could be made or otherwise implemented without departing from the principles of the present invention. Accordingly, the examples and drawings disclosed herein including the appendix are for purposes of illustrating the preferred embodiments of the present invention and are not to be construed as limiting the invention.

What is claimed is:

1. A flame augmentor for use in a jet engine, wherein the bluffbody base of said flame augmentor comprises a plurality of two-dimensional and three-dimensional geometrical features to enhance flameholding.

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